#11 SMC 1/2/02 (NE)

SUBSTITUTE SPECIFICATION

PORTABLE AUDIO PLAYBACK UNIT

Cross Reference

[0001] This application relates to, and is entitled to the benefit of the filing date of, U.S. Provisional Patent Application Serial No. 60/134,989 filed May 20, 1999, titled "Portable Audio Playback Unit" (attorney docket SYCO-0010) and U.S. Provisional Patent Application Serial No. 60/129,003 filed April 13, 1999, titled "Portable Audio Player" (attorney docket SYCO-0009).

Brief Summary of the Invention

[0002] The subject device is a Portable Audio Playback Unit, in which audio content can be written, stored, and retrieved. In addition, the unit can intelligently interact with the user, displaying non-audio information, accepting input from the user through a keyboard interface, and collecting statistics on the unit's usage.

Brief Description of the Drawings

[0003] Figures 1 and 2 are block diagrams which depict alternative embodiments of the inventive device.

Detailed Description of the Invention

[0004] The significant difference between the two embodiments shown in Figures 1 and 2 is that one employs a Static Random Access Memory (SRAM), while the other does not. This and other differences, are a matter of economics and availability of devices, and do not affect the overall function of the unit. Accordingly, the descriptions that follow relate to either block diagram as appropriate.

[0005] One particularly important aspect of the present invention is the use of a hard drive (such as the kind typically used in a laptop or notebook computer), which is a delicate and high power consuming device. Therefore, to use a hard drive in a portable, hand-held audio player, we had to find a way to both protect and reduce the power consumption of the hard drive.

[0006] In particular, the hard drive is subject to breakage if operated while the device is not stationary. This poses a significant problem for a portable, typically hand-held, device. In the present invention, we dealt with the ease of breakage in two ways: First we conducted a careful mechanical study to find the thickness of a reasonably available absorption material needed to be used to pass a 1 meter drop test. We discovered that 0.8 inches of such material is sufficient to protect the hard drive. Second, we devised a secondary stationary memory concept to be used as the active system during playback or recording. Here, the hard drive uploads an hour or so of material to the solid state memory and locks the drive. This process takes about 7 seconds. Thus, the disk medium is normally locked, especially while the unit is being carried about by the user.

[0007] The aforementioned power consumption problem was solved using the secondary memory as well, since the drive only needs to spin momentarily.

[0008] The various components of the presently preferred implementation will now be described.

[0009] Computer

[0010] This device is external to the subject Portable Audio Unit, and is shown for clarity and completeness. When the Unit is attached to the Computer, communication between the two can be achieved. Such communication may be done via a parallel port, a serial port, ATA bus or any other convenient means. Through this port, both audio and non-audio content is downloaded to the Unit, and Unit usage statistics are uploaded. If the Unit is used as a recorder, this port can be used to upload the recorded content to the Computer.

[0011] SYC801/SYC810

[0012] The components labelled SYC801 and SYC810 is Figures 1 and 2 are each a Digital Signal Processor (although the invention may employ any suitable type, not only those types explicitly shown), in which the major program for the overall operation of the Unit executes. The functions of this program are manifold, and include communication with the Computer, reading/writing data from/to the Flash and Disk

memories, compressing and de-compressing audio data, and communicating with the Microprocessor and Computer.

[0013] OSC

[0014] This Oscillator supplies the clock necessary for the operation of the DSP, and may be set at any convenient frequency, not just the 12.2880 MHz explicitly shown.

[0015] Microprocessor/Display/Keys

[0016] The microprocessor executes a program which interprets Key depressions from the user, and provides visual feedback and prompts on the Display. In addition, the Microprocessor program contains a Clock function, by which messages and prompts keyed to date and/or time can be activated without burdening the DSP which typically requires more power for this function.

[0017] Flash Memory

[0018] Flash memory is a non-volatile storage medium. Audio data can be loaded into Flash memory and the power subsequently removed to conserve energy. When the audio data is needed, power can be restored, and the data quickly accessed. (Note that the secondary memory is not limited to Flash memory, as SRAM, DRAM and other types of solid state memory may also be used.)

[0019] Hard Drive

[0020] Disk memory is another non-volatile storage medium. It is economical to store vast quantities of audio data on the Disk, ready for transfer to the Flash memory for quick processing as directed by the DSP.

[0021] As discussed above, an important aspect of the present invention is the use of a hard drive (such as the kind typically used in a laptop or notebook computer), which is a delicate and high power consuming device. Therefore, to use a hard drive in a portable, hand-held audio player, the hard drive must be protected and its power

consumption must be reduced. In accordance with the present invention, the hard drive is subject to breakage if operated while the device is not stationary. This poses a significant problem for a portable, typically hand-held, device. This is one reason why hard drives have never been used for portable devices. Another reason is because they were not built for that purpose. However, hard drives have one clear advantage over other media in that they are very mature technology and therefore have ridden far down the price performance curve. In the present invention, we dealt with the ease of breakage in two ways: First we conducted a careful mechanical study to find the thickness of a reasonably available absorption material needed to be used to pass a 1 meter drop test. We discovered that 0.8 inches of such material is sufficient to protect the hard drive. Second, we devised a secondary stationary memory concept to be used as the active system during playback or recording. Here, the hard drive uploads an hour or so of material to the solid state memory and locks the drive. This process takes about 7 seconds. Thus, the disk medium is normally locked, especially while the unit is being carried about by the user.

[0022] With regard to the absorption material, it should be noted that we have not yet identified the best material to use. We have determined that the properties for such a material are to absorb a high impact and also to provide a loose enough motion for normal motion. It is analogous to a car wheel suspension system but more complicated since it needs to perform 360 degrees. In a car, one needs to prevent damage from high impact and also to have a smooth ride over small bumps. These are competing constraints. There are many materials that may provide this but none has been selected yet. It may end up being a combination of a few. The measurements we performed were to define that deceleration needed to prevent the hard drive from breaking. This in turn allows for the definition of the types of materials we need.

[0023] Also, the Unit is designed so the hard drive can be disconnected from the Unit and the Unit can operate independently in case the user wants to use the device in a particularly harsh environment or to reduce the weight and size of the product for easier mobility.

[0024] The hard drive interfaces to a PC in a number of ways: (1) through an IDE interface that is very fast and acts as an external drive for the PC; (2) through a

USB (Universal Serial Bus) interface; and (3) through a parallel port interface. Other means of communication are also possible.

[0025] Other advantages of using a hard drive include:

- The hard drive can be changeable to upgrades in memory size as the densities grow.

- The volume of audio for the cost of the unit it the biggest novelty, using a mature technology, hard drive, for the purpose of providing an abundance of audio.

- Compression algorithms, such as MP3, are used to maximize the amount of audio for the amount of memory (typically, 100kbit per minute) at CD-like quality.

- We propose to use the 2.5" laptop-type drive since it is inexpensive and designed for relative durability. However, smaller drives may make more sense in the future.

- The present invention is also advantageous in high volume recording applications. One issue with portable digital recorders is that memory is expensive, and so time is relatively limited. The use of a high capacity hard drive remedies this problem.

- The present invention may also be expanded to video and digital cameras.

- The algorithms can be loaded from the hard drive to offer different algorithms in the future.

[0026] SRAM

[0027] It may be convenient and economical to store some of the DSP's program external to the DSP itself. This Static Random Access Memory is intended for that purpose, although DRAM may also be used.

[0028] DAC

[0029] Audio data, after being decompressed or otherwise manipulated by the DSP, is presented to this Digital-to-Analog Converter (DAC). The digital data, in conjunction with various clocking signals, is converted to a smoothly-varying analog signal representative of the intended sound. In addition, separation of Left and Right Audio signals takes place within the DAC.

[0030] AMP

[0031] The audio signal is Amplified to a level suitable for speakers or headphones.

[0032] Other Applications

[0033] Audio can be downloaded from the Internet, stripped from personal CDs (compact disks) and loaded into the hard drive, and/or recorded and ported to the hard drive.

[0034] In addition, a wireless interface to the unit can offer a way to transfer audio/video (AV) information.

[0035] The inventive device may also be used in an automobile. For example, the unit can be built into an auto panel system and audio can be ported to the unit in a number of ways: (1) audio can be loaded onto the unit's hard drive by a portable PC; (2) the hard drive can be removed and interfaced to a PC for loading of the audio; (3) the audio can be recorded from the automobile's radio; and/or (4) dictation can be taken in the car using a microphone.

Conclusion

[0036] The foregoing, although fairly complete, is not all-inclusive, and some functional blocks not directly related to the major purpose of Audio Playback may not be explicitly shown. In particular, the battery power source and any battery-sensing and battery-recharge functions have not been explicitly shown or described.